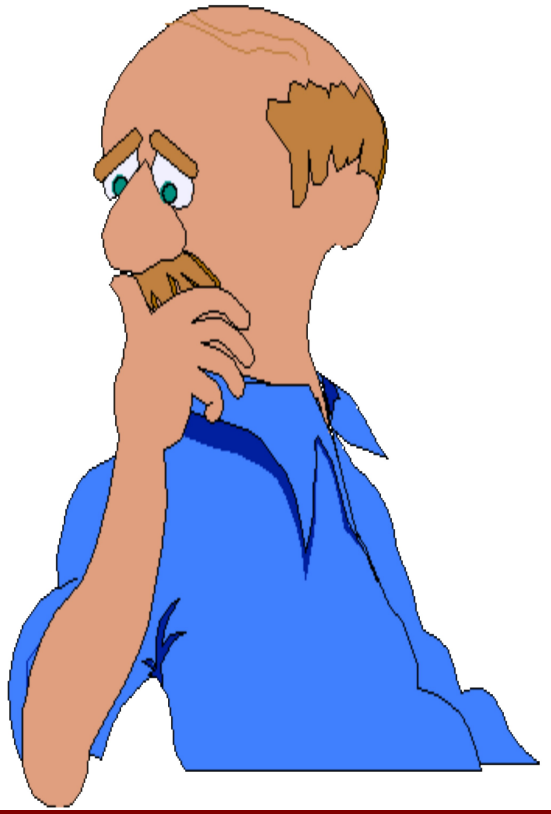
BAMC Radiation Safety Training

Congratulations, you have begun the BAMC Radiation Safety Office online radiation safety training course for x-ray users.

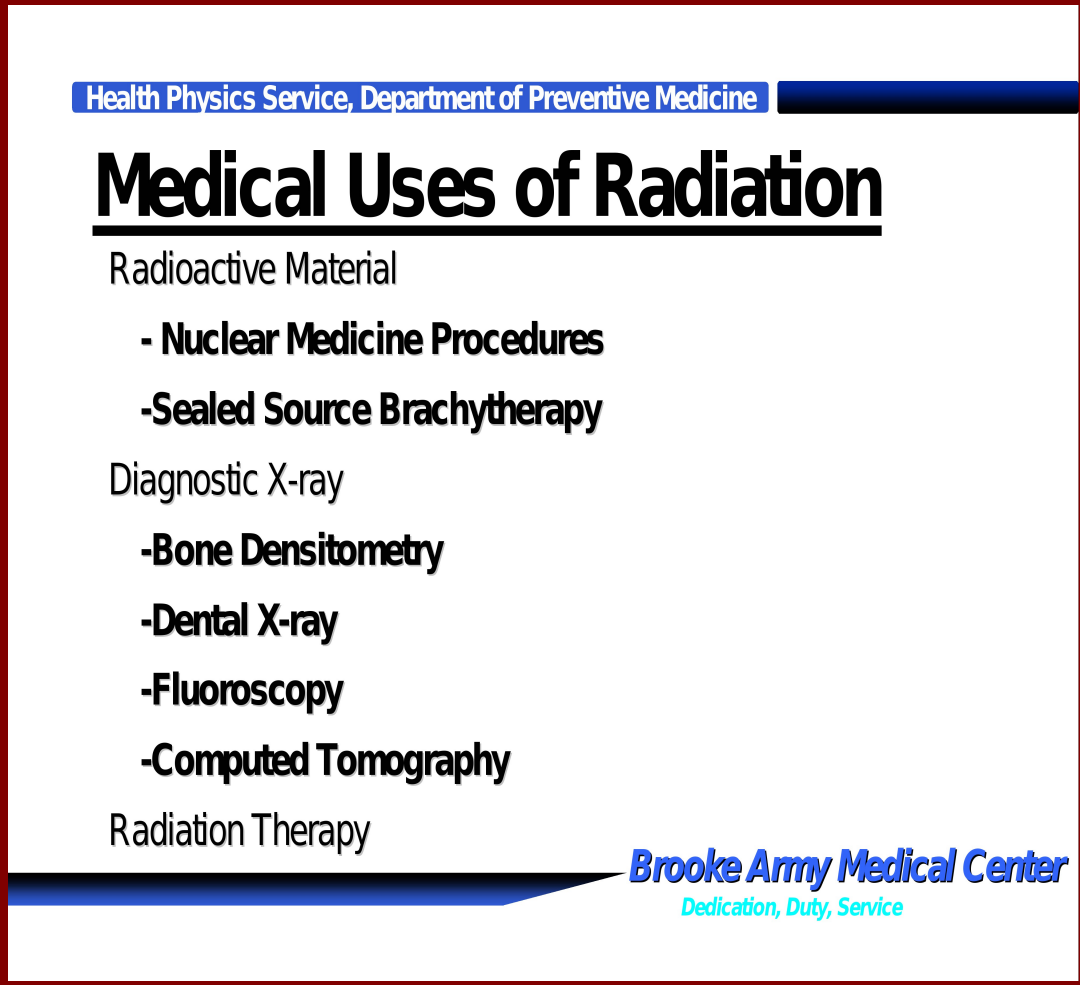
Training Outline

- *Authorized Users*
- *X-ray Radiation*
- *Radiation Dose*
- *Radiation Effects*
- *Radiation Dosimetry*
- *Policies and Regulations*

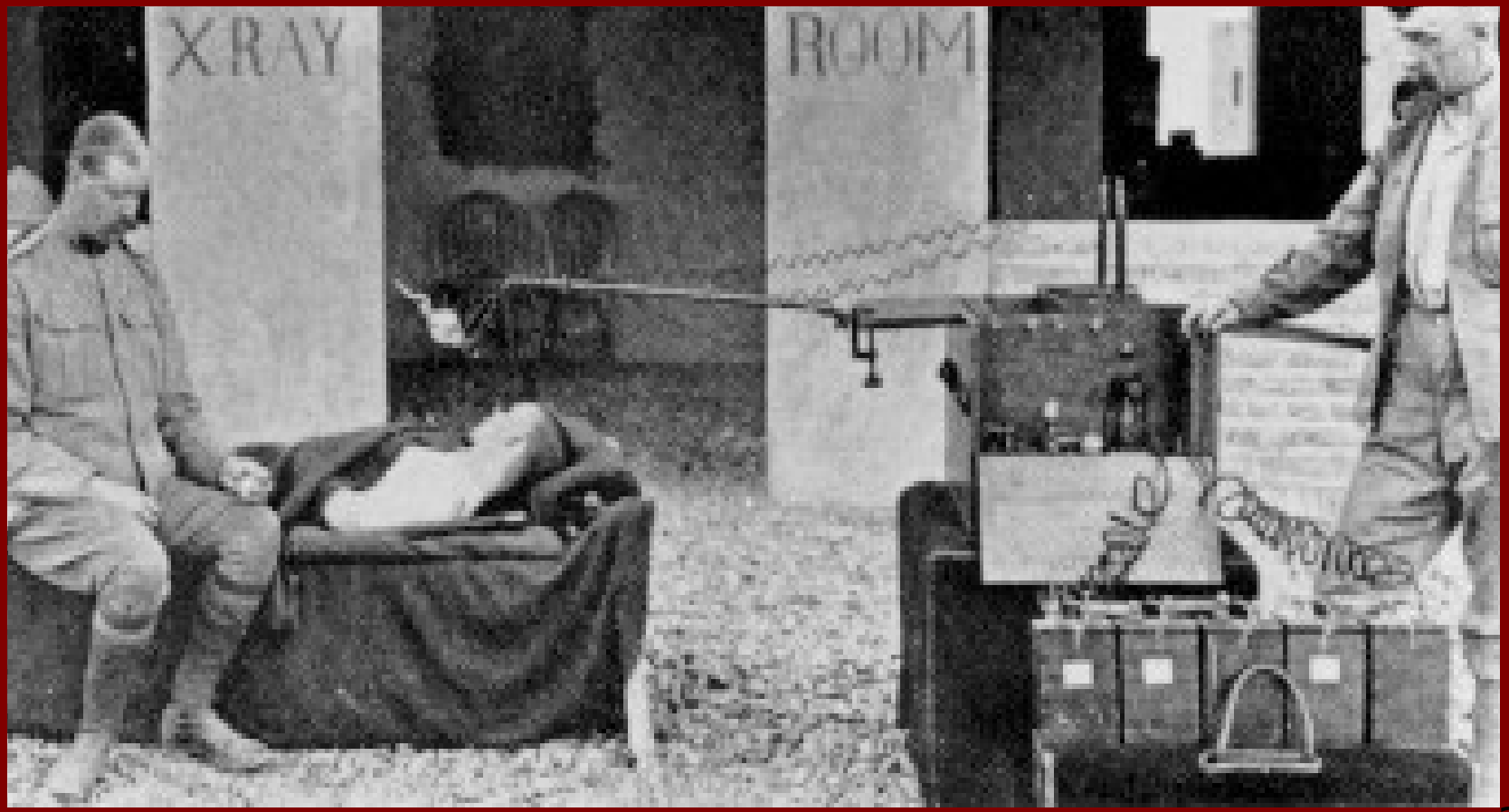


BAMC Radiation Safety Training

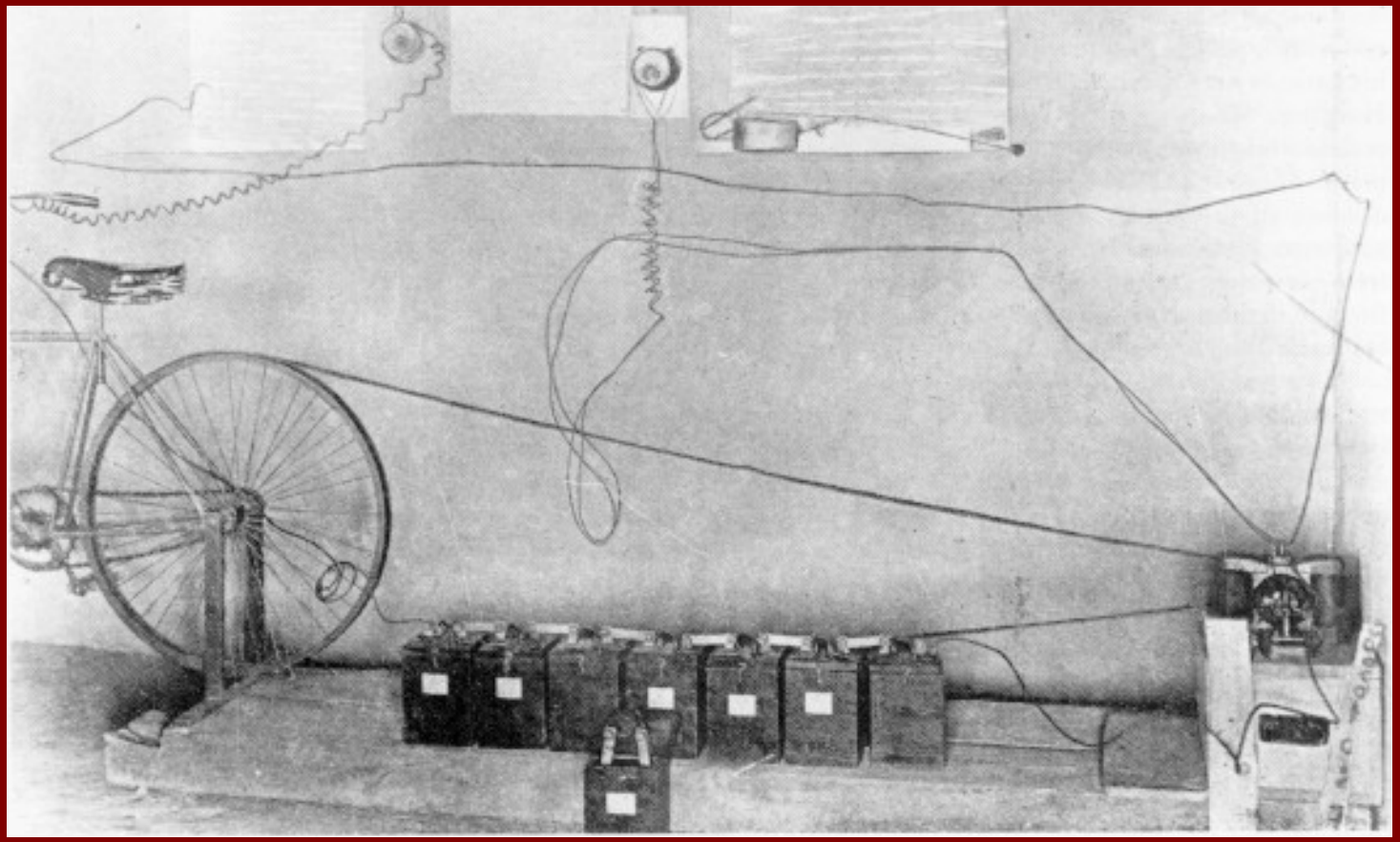
All individuals that use radioactive materials or x-ray equipment at BAMC must satisfy the conditions and requirements specified in ARMY regulations, BAMC Department of Radiology Policies and the BAMC Radiation Safety Manual. The uses of radioactive material and x-ray equipment in the health professions is governed by Code of Federal Regulations, Titles 10 (NRC); 21 (FDA); 29 (OSHA); AR 11-9 The Army Radiation Safety Program, DA Pam 40-18 (Dosimetry Procedures), and TB Med 521 (Performance testing)



Medical Use of X-Rays 1899



Medical Use of X-Rays 1899

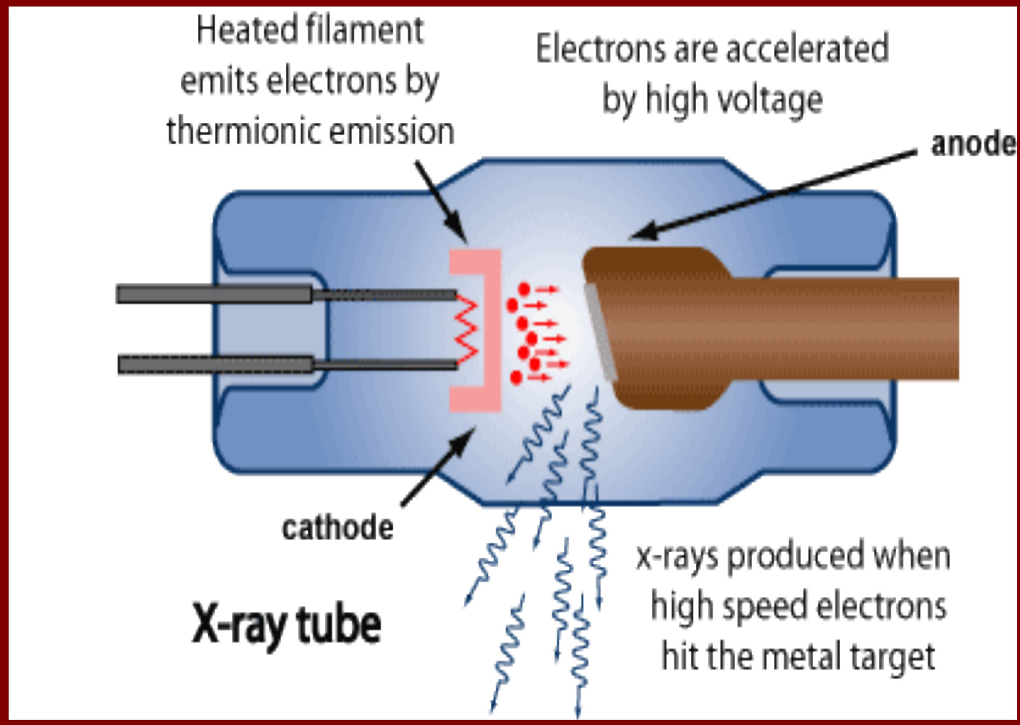


BAMC Radiation Safety Training

X-rays are produced in an x-ray tube through a Bremsstrahlung interaction. Electrons are bubbled off a filament heated with electric current. The electrons are accelerated toward the anode across an electrical potential under a vacuum. The high energy beta particles interact with the nuclei of the atoms that make up the anode and produce Bremmstrahlung x-ray radiation. Negatively charged beta particles decelerate around the positively charged nuclei in the anode and loose kinetic energy. This energy is emitted in the form of electromagnetic radiation called x-ray radiation.

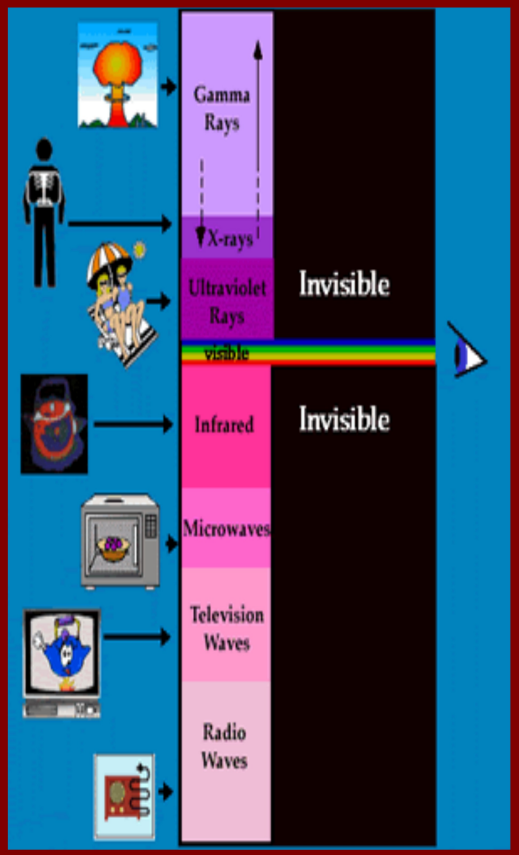
Bremsstrahlung in an X-ray Tube

High electrons strike a tungsten target to produce X-rays.


Heated filament emits electrons by thermionic emission
Electrons are accelerated by high voltage
anode
cathode
X-ray tube
x-rays produced when high speed electrons hit the metal target

BAMC Radiation Safety Training

The electromagnetic spectrum is the range of electromagnetic radiation, beginning with radio waves and extending through visible light all the way to high energy ionizing radiation (x-rays and gamma rays). Unlike lower energy electromagnetic radiation, ionizing radiation is energetic enough to damage critical molecules in the body's cells through direct ionization and the formation of free radicals.



Oscillating electric and magnetic fields transfer energy to matter via photon or wave interactions.

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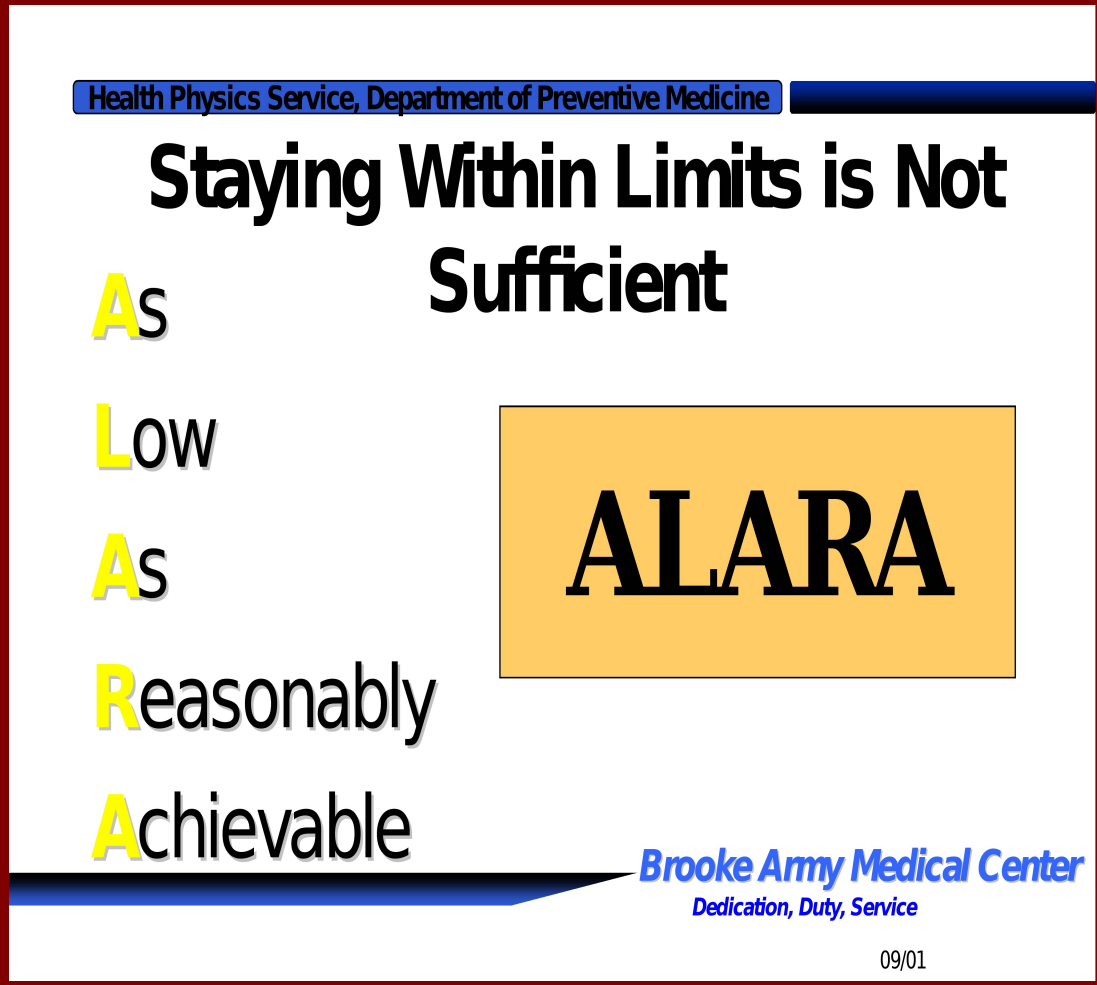
The goal of the ALARA principle is to maintain individual and collective doses from ionizing radiation as low as reasonably achievable. In many cases simple engineering controls and procedural changes can greatly reduce one's radiation exposure. The ALARA philosophy encourages everyone to actively seek out methods of exposure reduction.

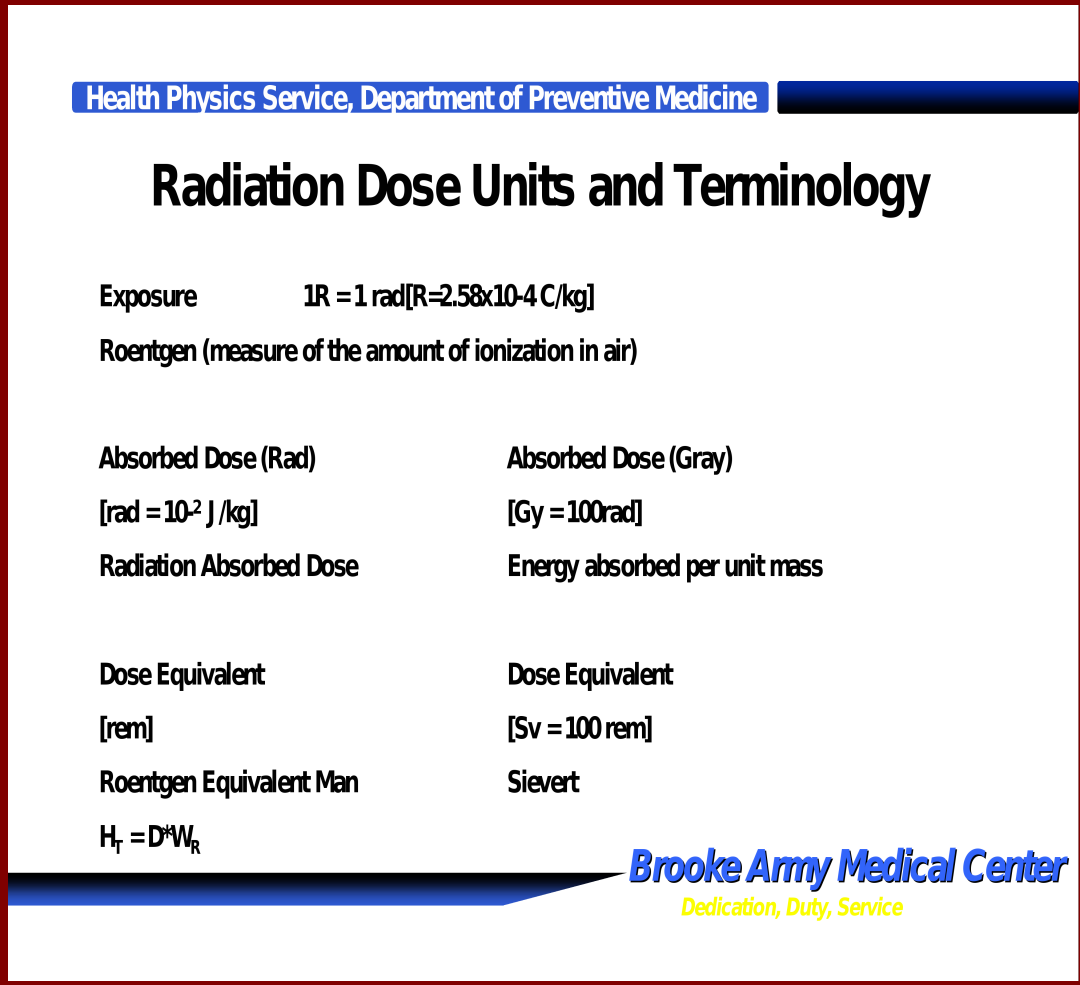


BAMC Radiation Safety Training

Exposure is a measure of the ionization of air by electromagnetic radiation. The unit of measure for exposure is the Roentgen. Most gas filled detectors measure exposure and the results are given in mR/hr (mill Roentgen/hour)

The rad is a unit of measure for absorbed dose. Absorbed dose is the amount of energy absorbed by tissue per unit mass of tissue. Absorbed dose in tissue is approximate equal to exposure.

The rem is a unit of measure for dose equivalent. The dose equivalent is equal to the absorbed dose for x-ray, gamma and beta radiation.



BAMC Radiation Safety Training

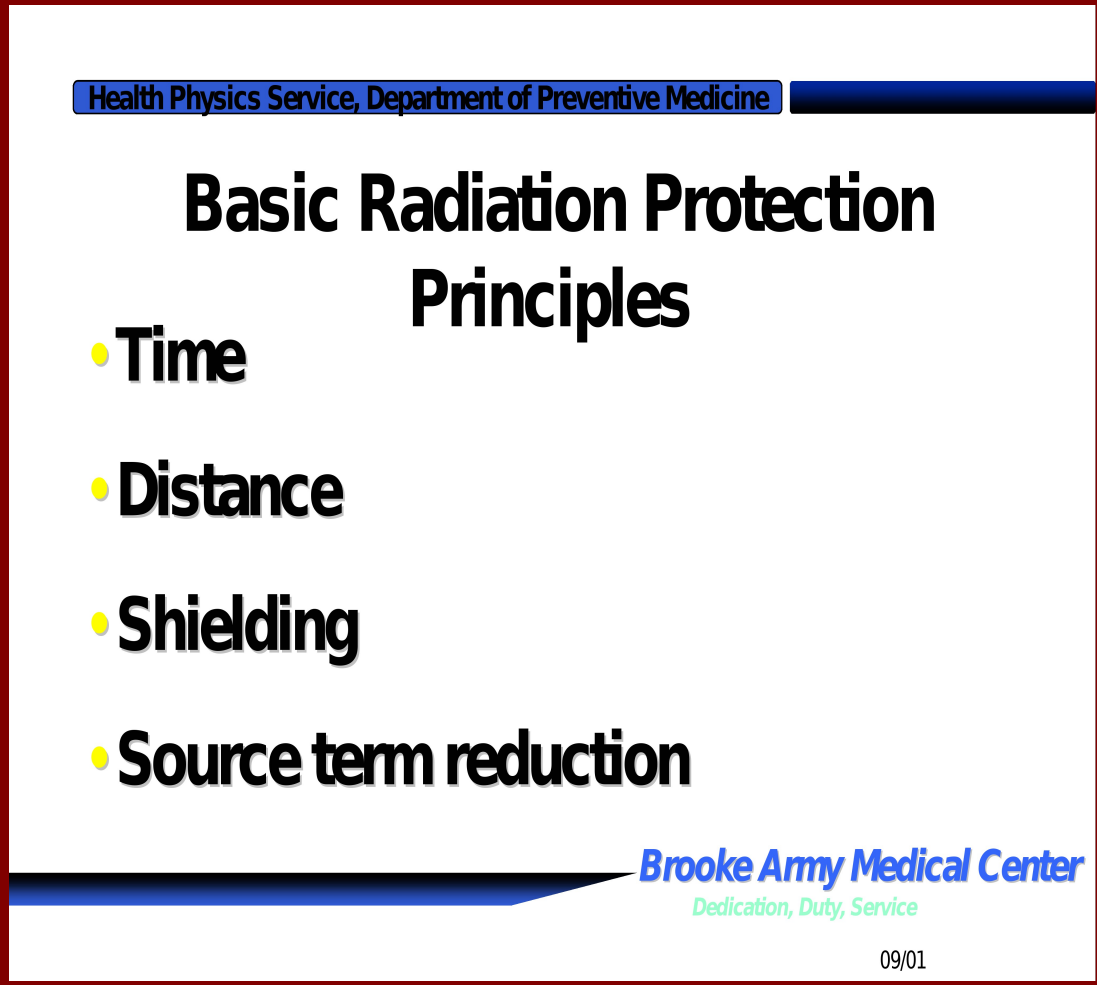
The table to the right summarizes the annual maximum allowable dose limits for occupationally exposed individuals. Extremities include the arms below the elbow and the legs below the knee. The last row in the table is the dose limit for members of the general public. The dose to individual members of the public from the use and disposal of radioactive material and radiation producing machines can not exceed 100mrem.

Ionizing Radiation Annual Occupational Dose Limits

Background		**300 mrem**
Whole Body	**5 rem**	**5000 mrem**
Eyes	**15 rem**	**15,000 mrem**
Extremities	**50 rem**	**50,000 mrem**
Skin	**50 rem**	**50,000 mrem**
Fetal	**.5 rem**	**500 rem**
General Public	**.1 rem**	**100 rem**

BAMC Radiation Safety Training

The three main principles by which exposure to external radiation is reduced are time, distance and shielding. Limiting the time you are around sources of radiation will reduce your exposure. Since your exposure increases with the inverse square of the distance from radiation sources, maximizing your distance will significantly decrease your exposure. Finally, employing the shielding appropriate to the type of radiation you are using greatly reduces your exposure.



BAMC Radiation Safety Training

Only personnel essential to the medical procedure are allowed in the examination room during radiographic imagining other than the patient being examined. All individuals present shall be positioned such that no part of the body will be struck by the useful beam, unless protected by not less than 0.25 mm lead equivalent material. X-ray operators, other staff, and ancillary persons are required to be protected from the direct scatter radiation by protective aprons or whole body protective barriers of not less than 0.25 mm lead equivalent material. Thyroid shields and lead glasses are also strongly recommended.

Health Physics Service, Department of Preventive Medicine

Shielding

- 0.25 mm lead equivalent
- Between radiologist and patient
- ➢ Exposures exceed 100 mR/hr @ 2 ft without drapes

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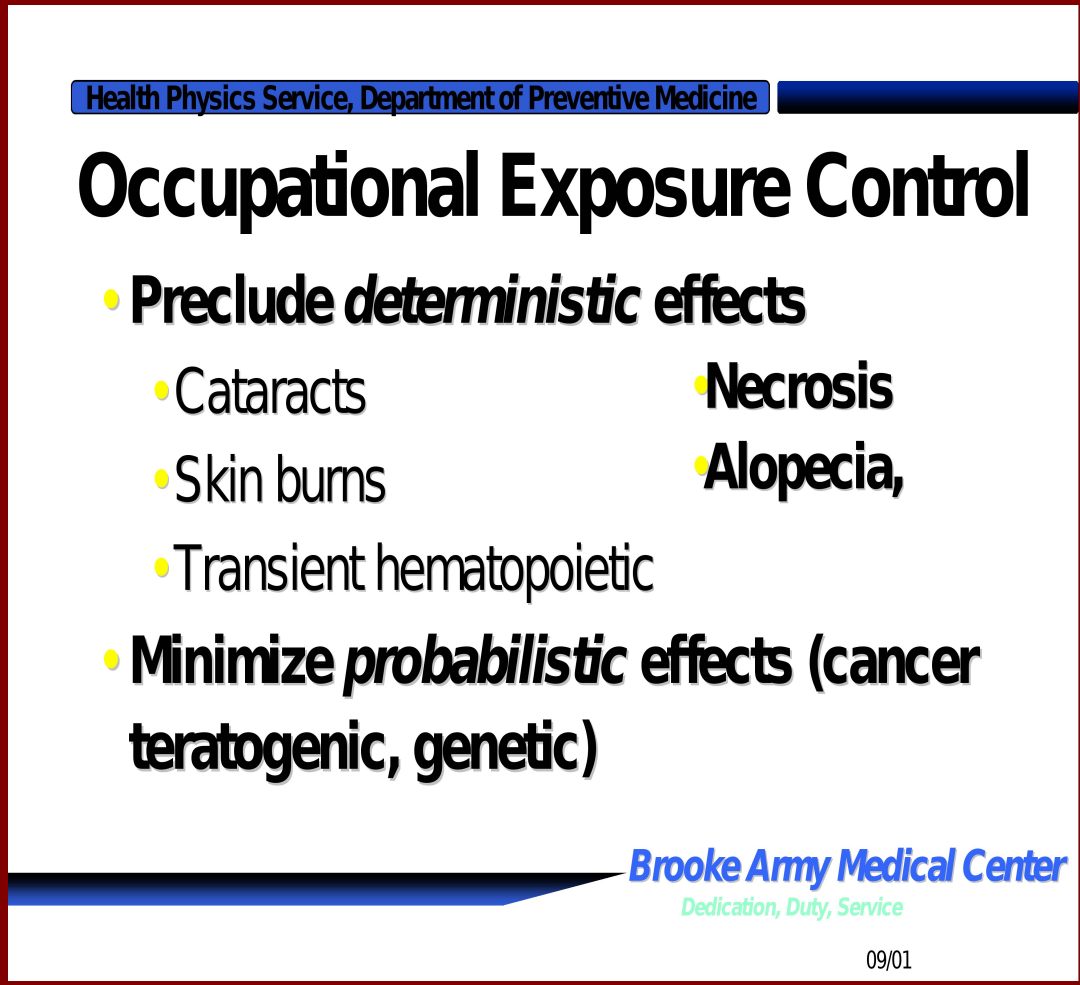
Deterministic health effects generally result from the receipt of a relatively high dose over a short period of time. The severity of deterministic effects vary with the dose and have a minimum threshold dose. Skin erythemia (reddening) and radiation-induced cataract formation are examples of deterministic effects.

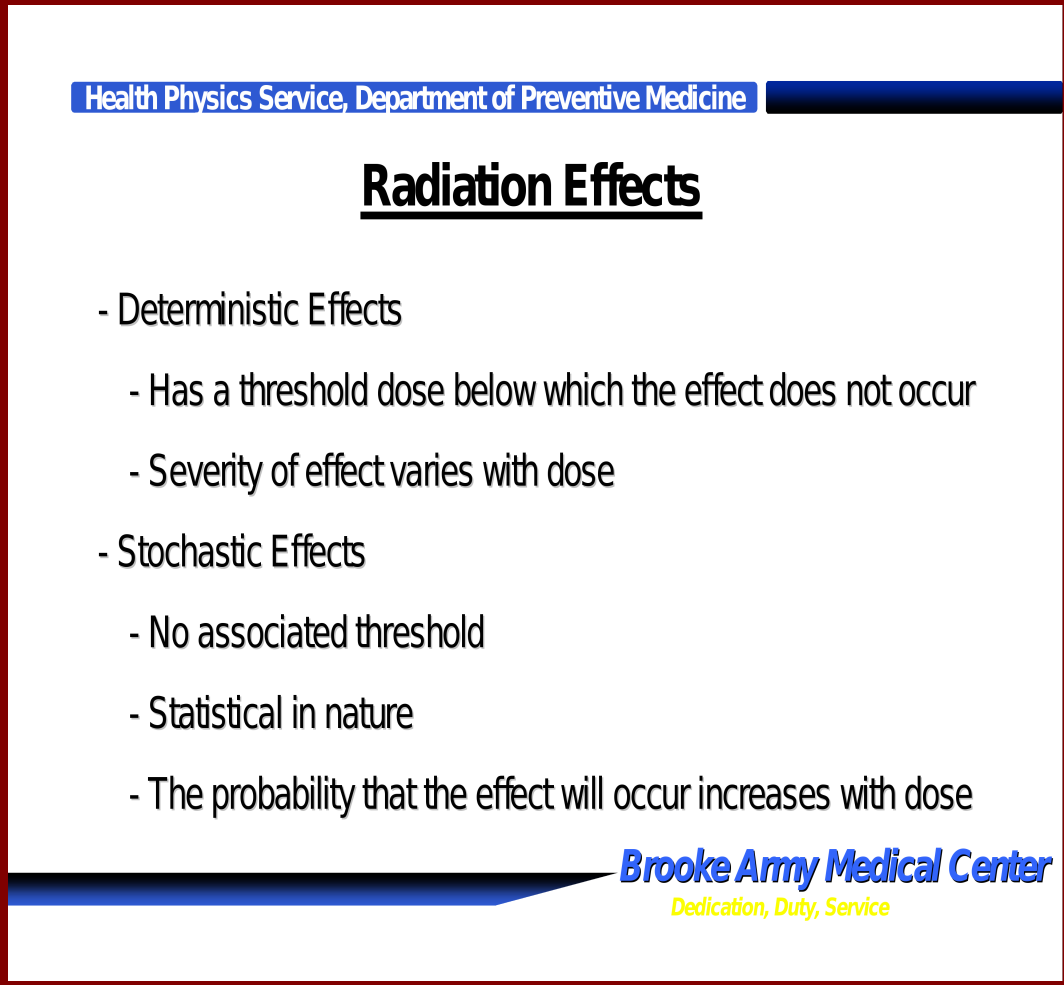
Stochastic effects occur by chance and may occur without a threshold dose. The probability that the effect will occur is proportional to the dose but the severity of the effect is independent of the dose. In the context of radiation protection, the main stochastic effect of concern is cancer induction.



BAMC Radiation Safety Training

Deterministic effects occur at large acute doses in the tens to hundreds of rem range - well above regulatory dose limits.

Current radiation protection standards and practices are based on the premise that any radiation dose, no matter how small can result in stochastic effects. In other words, a small increase in radiation dose produces a small increase in the likelihood of developing cancer. This relationship is known as the Linear No-Threshold (LNT) model.


Health Physics Service, Department of Preventive Medicine
Radiation Effects
- Deterministic Effects
- Has a threshold dose below which the effect does not occur
- Severity of effect varies with dose
- Stochastic Effects
- No associated threshold
- Statistical in nature
- The probability that the effect will occur increases with dose
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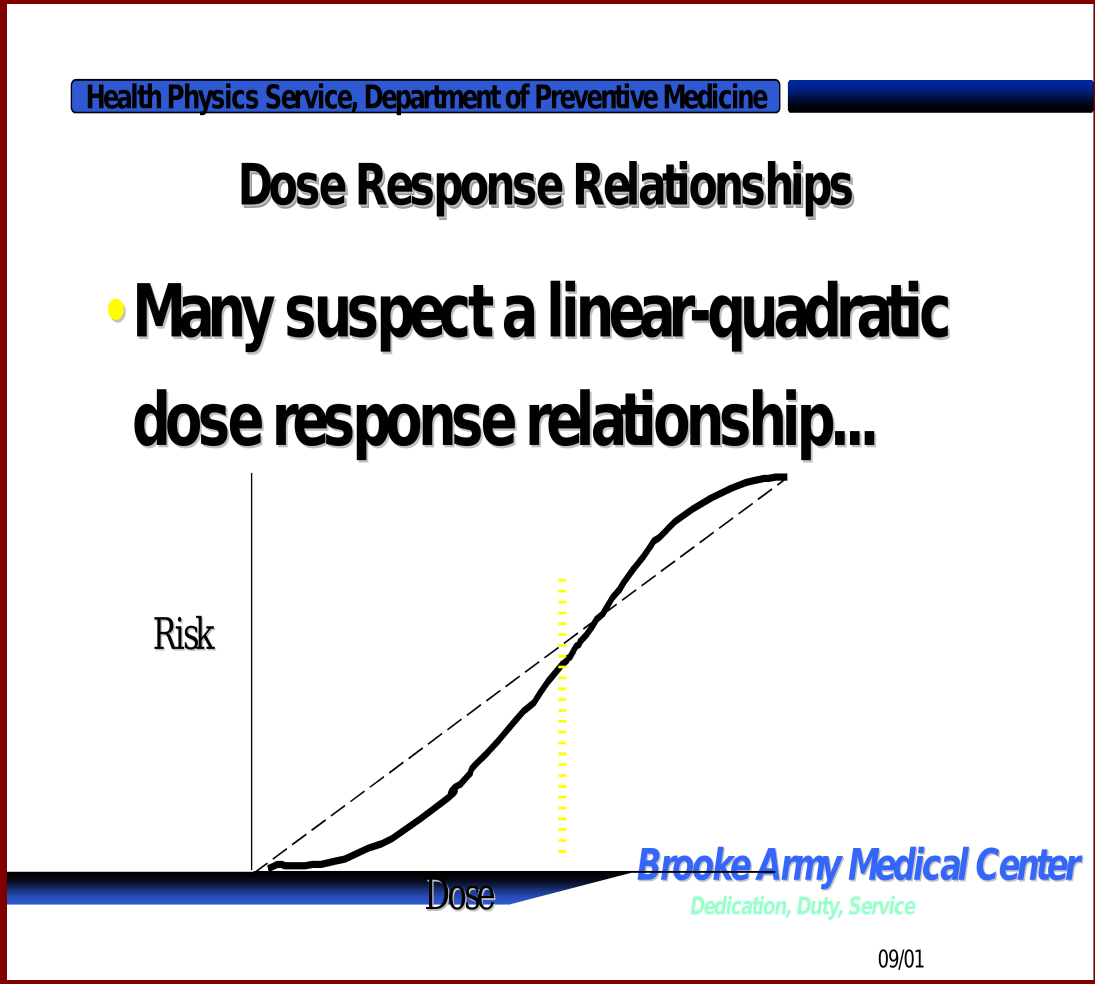
BAMC Radiation Safety Training

There is substantial scientific evidence that the LNT model (shown in dotted line) is an oversimplification of the dose-response relationship and results in an overestimation of health risks at low doses. Biological mechanisms including cellular repair of radiation injury, are not accounted for in the LNT model. A linear-quadratic model (show in solid curved line) has been proposed which might better describe the dose-response relationship. This model includes a threshold (speculatively as high as 10 rem) below which no effect would be observed. Current radiation dose limits are based on the LNT model which is thought to be conservatively safe.



BAMC Radiation Safety Training

Another radiation protection concern is the effect of in-utero irradiation of the fetus. These effects have been observed at large acute doses of radiation but are unlikely to occur at doses less than 10 rem.

Health Physics Service, Department of Preventive Medicine

Fetal Exposure Considerations

- First Two Weeks
  - At high doses: fetal death
- Weeks 2-15
  - Major organs are developing
  - High doses can cause congenital abnormalities, especially in the brain

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Health Physics Service, Department of Preventive Medicine

Fetal Exposure Considerations

- Weeks 16 until birth
  - Risks similar to the risks for a newborn
- Occupationally: Limit = 0.5 rem
  - Fetus treated as member of the public
  - Mother must declare pregnancy
  - Controlled to 50 mrem/month to spread dose across the 10 months

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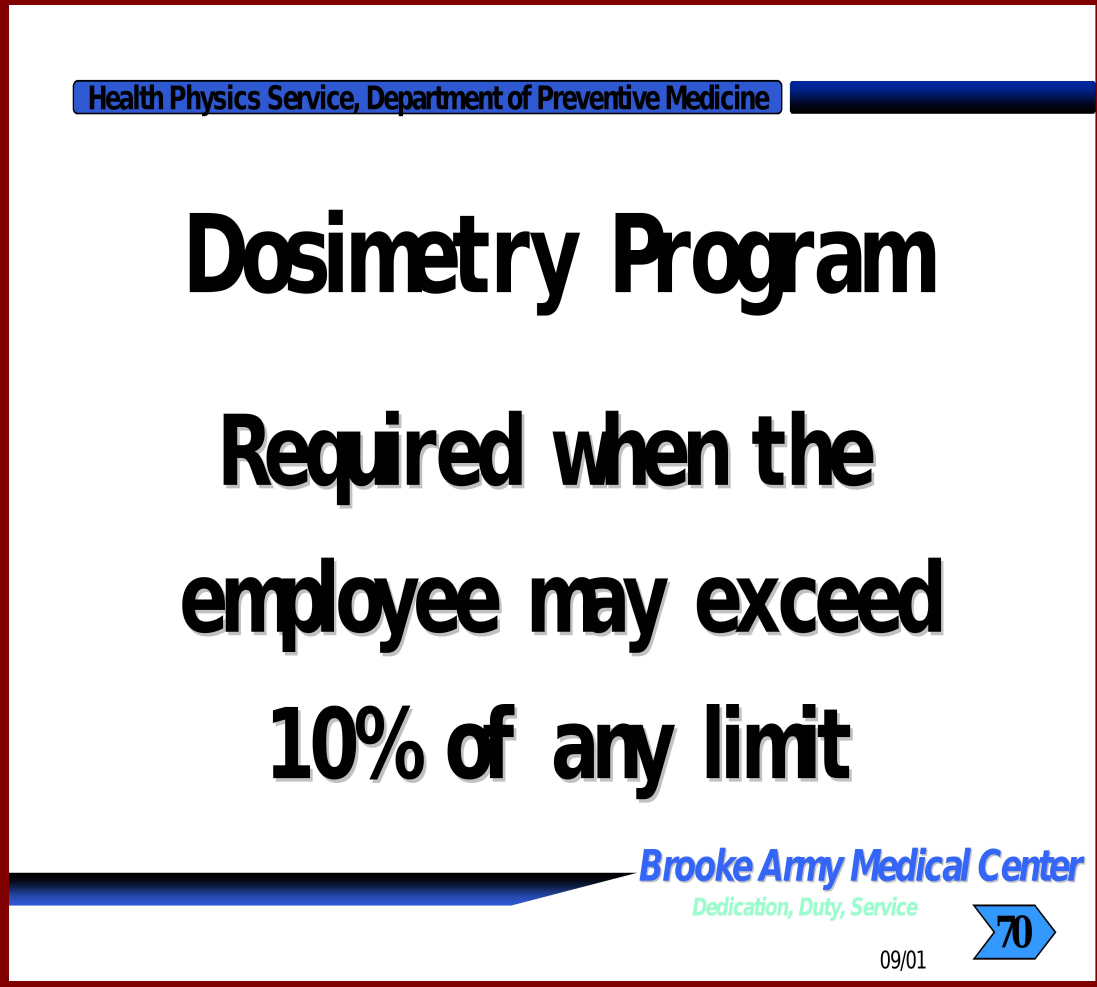
BAMC Radiation Safety Training

The Radiation Safety Office provides radiation monitoring to BAMC employees for the purpose of demonstrating compliance with the occupational dose limits and to ensure a safe working environment. Individuals that meet any of the criteria that require monitoring must participate in the BAMC Radiation Safety Office Dosimetry Badge Program. Also, no individual may enter a fluoroscopic procedure room while the x-ray machine is in use unless they are wearing a personal radiation monitor.


Health Physics Service, Department of Preventive Medicine
Dosimetry Program
Required when the employee may exceed 10% of any limit
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70
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BAMC Radiation Safety Training

There are several types of badges that monitor different types of exposure. Be sure that you are familiar with the badges you are issued and know how to wear them properly. If you have any questions regarding radiation dosimeter badges please contact the Radiation Safety Office.

A pregnant individual must declare her pregnancy by written notification in order to enact the lower exposure limit for pregnant individuals and to receive a fetal monitor. Declaration of your pregnancy is strictly voluntary.

Health Physics Service, Department of Preventive Medicine
There are 5 types of badges
Whole Body Badge
- Worn between the waist and neck.
Collar Badges
- Worn at the collar outside the lead apron.
Wrist Badge
- Worn on the wrist when it is not feasible to wear a ring badge.
Ring Badge
- Worn on the index finger of the dominant hand.
Fetal Badge
- Worn at the waist under the lead apron.
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BAMC Radiation Safety Training

Dosimetry badges are intended to measure your external occupational radiation exposure received while working at BAMC. A new badge is issued to you each month. Wear each badge only during the month indicated on the badge. If your badge is lost or damaged call the Radiation Safety Office immediately for a replacement.

Health Physics Service, Department of Preventive Medicine
Dosimetry Badges
- Are designed to detect external exposure
- Are for occupational exposures only
- Are not protective devices
- Can be affected by intense heat/humidity
- Are not foolproof. Always obey other safety requirements.
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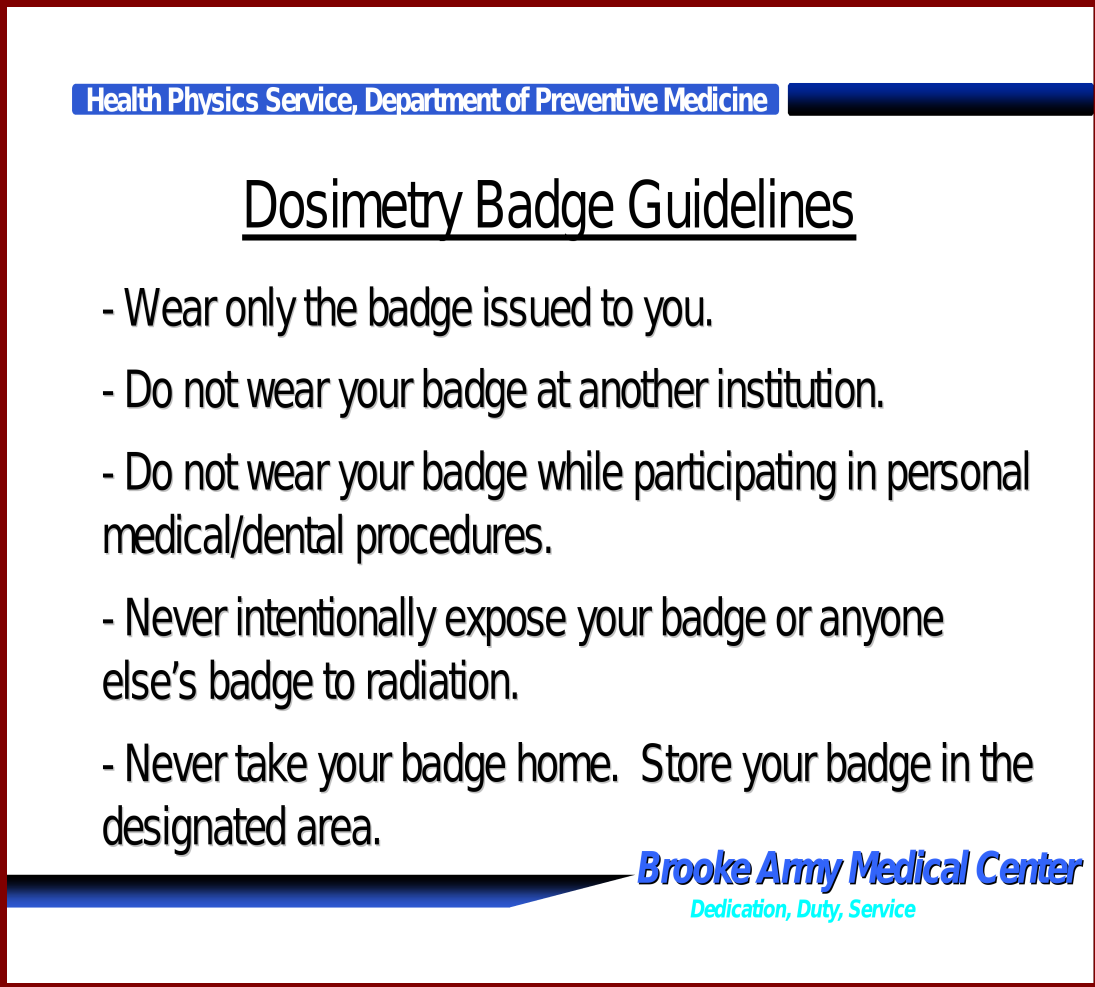
BAMC Radiation Safety Training

If you are issued a dosimetry badge follow these guidelines. Your badge is your responsibility and all readings are permanently recorded in your dosimetry history. Your dosimetry history is available from the Radiation Safety Office by written request.


Health Physics Service, Department of Preventive Medicine
Dosimetry Badge Guidelines
- Wear only the badge issued to you.
- Do not wear your badge at another institution.
- Do not wear your badge while participating in personal medical/dental procedures.
- Never intentionally expose your badge or anyone else's badge to radiation.
- Never take your badge home. Store your badge in the designated area.
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BAMC Radiation Safety Training

ALARA INVESTIGATIONS

- **CATEGORY LEVEL 1 LEVEL 2**
- **Whole Body 125 mrem 375 mrem**
- **Eye 375 mrem 1126 mrem**
- **Skin/extremity 1250 mrem 3750 mrem**

Dosimetry reports are sent to each department on a monthly basis. The report summarizes the radiation dose received by individuals participating in the dosimetry badge program. It is highly recommended that you review the radiation dose reports for your badge. If you have any questions regarding the reports please contact the Radiation Safety Office.

Automated Dosimetry Report

PCN V60QD10034A

FOR OFFICIAL USE ONLY
PRIVACY ACT DATA

DATE 06/23/95 ANNUAL/QUARTERLY HISTORY OF EXPOSURE TO IONIZING RADIATION PAGE 001

NAME DOE, JOHN Q.
SSN 000-00-0000
DATE OF BIRTH 07/01/58
OCCUPATION CODE
SEX
PERMISSIBLE LIFETIME DOSE 085.000

ALL DOSES REPORTED IN REM

PERIOD WORN FROM	TO	ACCT NR	DOS NR	DOS CD	NOTE CD	DOSE THIS PERIOD SHALLOW EYE	DEEP	DOSE THIS QTR SHALLOW EYE	TEDE	DOSE THIS YEAR SHALLOW EYE	TEDE	LIFETIME TEDE
01/08/95	02/11/95	AFI	0153506	AA		000.043	000.041 000.035					000.536
01/08/95	02/11/95	AFI	0144176	DA		000.046	000.045 000.044	000.046	000.045 000.044	000.046	000.045 000.044	000.580
01/10/95	02/09/95	AFI	0000000	BC	H	000.310		000.310		000.310		
02/12/95	03/09/95	AFI	0073257	AA		000.033	000.031 000.031	000.079	000.076 000.075	000.079	000.076 000.075	000.610
02/12/95	03/09/95	AFI	0079275	DA		000.012	000.011 000.008					
02/10/95	03/09/95	AFI	0000000	BC	H	000.140	000.000	000.450		000.450		
03/10/95	04/09/95	AFI	0000000	BC	H	000.460	000.000	000.910		000.910		
03/12/95	04/08/95	AFI	0066501	AA		000.015	000.015 000.015					
03/12/95	04/08/95	AFI	0100930	DA		000.020	000.019 000.018	000.099	000.095 000.093	000.099	000.095 000.093	000.703

THIS REPORT IS FURNISHED TO YOU UNDER THE PROVISIONS OF THE U.S. NUCLEAR REGULATORY COMMISSION REGULATIONS (10 CFR 19) OR THE DEPARTMENT OF LABOR REGULATIONS (29 CFR 1910). YOU SHOULD PERSERVE THIS REPORT FOR FUTURE REFERENCE.

AFI BROOKE ARMY MEDICAL CENTER
HEALTH PHYSICS OFFICE
MCHE-DHR
BUILDING 1188
FORT SAM HOUSTON TX 78234-6390

BAMC Radiation Safety Training

The BAMC Radiation Safety Office is responsible for the safety of all x-ray machines registered with the BAMC Medical Maintenance Department. Before any new x-ray equipment is purchased, installed or operated the Radiation Safety Office and Medical Maintenance must be notified. BAMC requires that all machines be registered, have an approved shielding design and have a shielding survey performed before the machine is operated. Also, the Radiation Safety Office must be notified before any x-ray machine is moved or disposed in order to maintain compliance with installation registration and regulatory requirements.

Health Physics Service, Department of Preventive Medicine
X-ray Machine Registration
Notify the Radiation Safety Office Before:
- Purchasing new X-ray equipment
- Installing new X-ray equipment
- Operating new X-ray equipment
- Moving any X-ray equipment
- Disposing of any X-ray equipment
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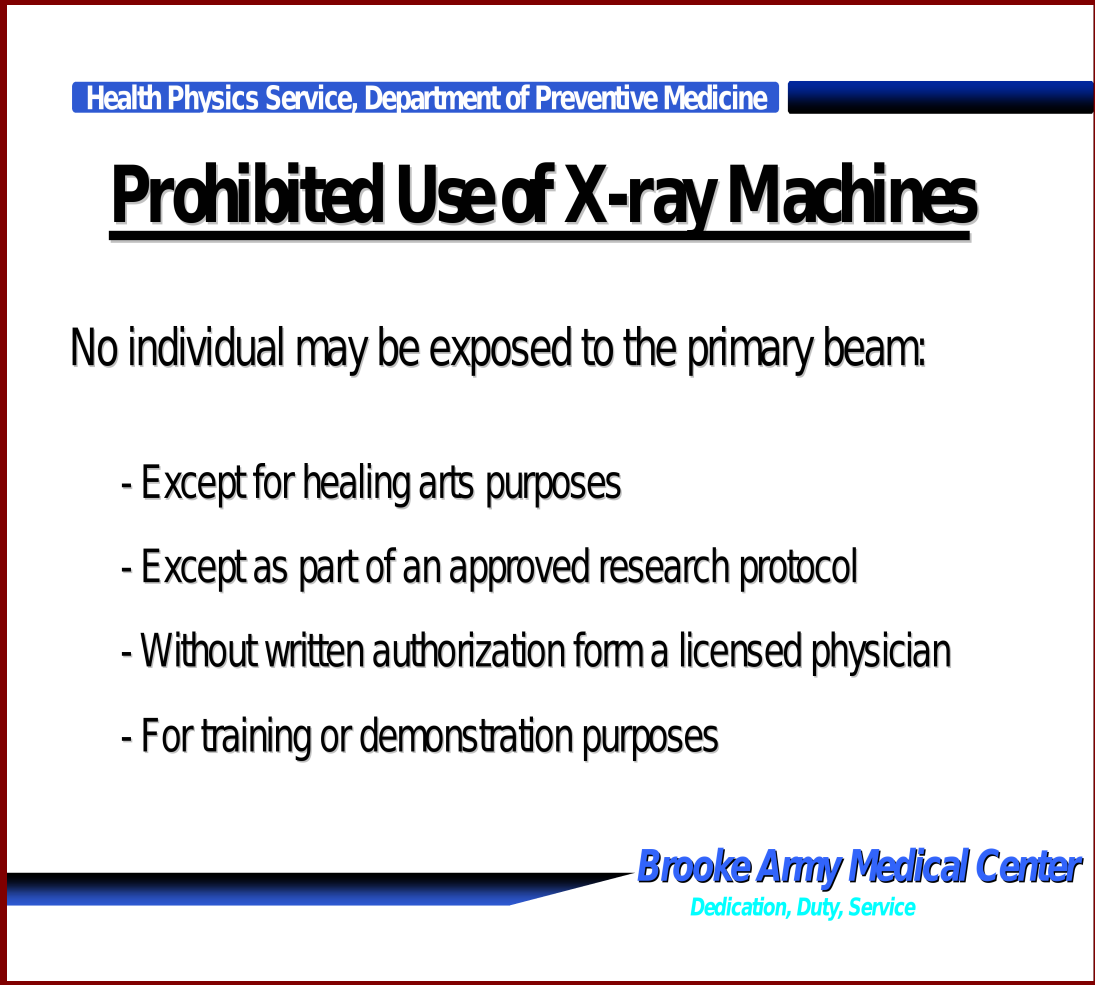
BAMC Radiation Safety Training

It is unlawful to operate any x-ray equipment at BAMC unless it is operated in compliance with all provisions of BAMC regulations. The use of x-ray radiation on humans is strictly regulated and is only permitted with written authorization from a licensed physician for healing arts purposes or as part of an BAMC approved research study. Individuals can not be exposed to x-ray radiation for training or demonstration purposes.


Health Physics Service, Department of Preventive Medicine
Prohibited Use of X-ray Machines
No individual may be exposed to the primary beam:
- Except for healing arts purposes
- Except as part of an approved research protocol
- Without written authorization form a licensed physician
- For training or demonstration purposes
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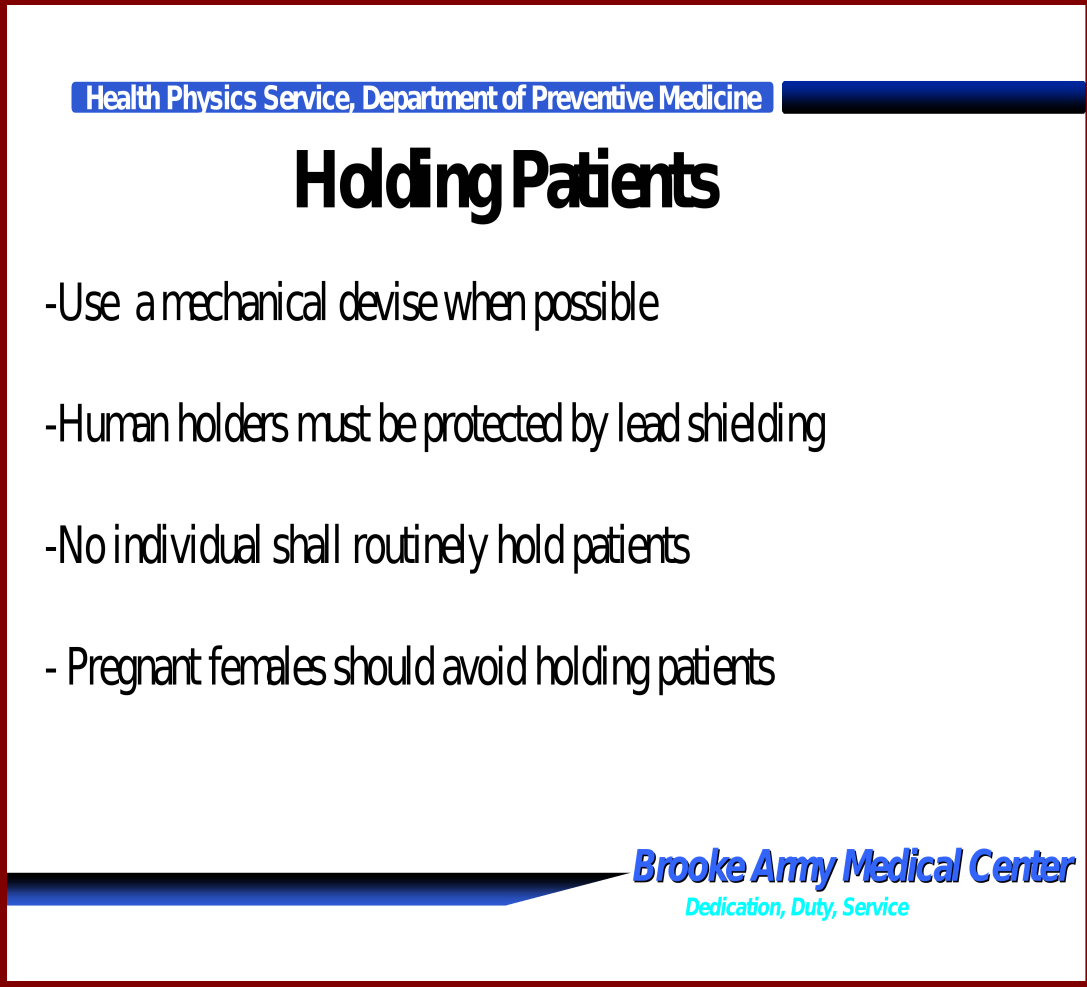
BAMC Radiation Safety Training

When at all possible, employees should not hold patients when radiographic images are being obtained. In cases were a person must hold the patient, the individual must have radiation safety training and must be protected by lead shielding. Pregnant females should not hold patients during x-ray examinations.


Health Physics Service, Department of Preventive Medicine
Holding Patients
-Use a mechanical devise when possible
-Human holders must be protected by lead shielding
-No individual shall routinely hold patients
- Pregnant females should avoid holding patients
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BAMC Radiation Safety Training

This concludes the presentation section of the BAMC Radiation Safety Office radiation safety training for x-ray users.

Thank You

The End!!

Click here for test

Some information for this presentation was taken from the MUSC Radiation Safety Office training class.